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LABORATORY STUDIES OF REFRACTORY METAL OXIDE SMOKES

J. A. Nuth*, R. N. Nelson** and B. Donn*
* Code 691, NASA/Goddard Space Flight Center,
Greenbelt, MD 20771
**Chemistry Dept., Georgia Southern College,
Statesboro, GA 30460

Studies of the properties of refractory metal oxide smokes condensed from a gas containing various combinations of SiH_4 , $\text{Fe}(\text{CO})_5$, $\text{Al}(\text{CH}_3)_3$, TiCl_4 , O_2 and N_2O in a hydrogen carrier stream at $500 \text{ K} < T < 1500 \text{ K}$ have been performed in our laboratory. Ultraviolet, visible and infrared spectra of pure, amorphous SiO_x , FeO_x , AlO_x and TiO_x smokes will be discussed, as will the spectra of various co-condensed amorphous oxides, such as Fe_xSiO_y or Fe_xAlO_y . Preliminary studies of the changes induced in the infrared spectra of iron-containing oxide smokes by vacuum thermal annealing suggest that such materials become increasingly opaque in the near infrared with increased processing: hydration may have the opposite effect (see Fig. 1). More work on the processing of these materials is required to confirm such a trend: this work is currently in progress. Preliminary studies of the ultraviolet spectra of amorphous Si_2O_3 and MgSiO_x smokes revealed no interesting features in the region from 200-300 nm. Studies of the ultraviolet spectra of both amorphous, hydrated and annealed SiO_x , TiO_x , AlO_x and FeO_x smokes are currently in progress.

Finally, data on the oxygen isotopic composition of the smokes produced in our experiments will be presented which indicate that the oxygen becomes isotopically fractionated during grain condensation. Oxygen in our grains is as much as 3% per amu lighter than the oxygen in the original gas stream. We are currently conducting experiments to understand the

mechanism by which fractionation occurs. Such processes may have observable consequences in circumstellar outflows if the effects become larger as the total pressure decreases. This might be expected if the fractionation mechanism operates during the formation of the initial molecular oxides rather than during the nucleation of the refractory grains which form from such oxides.

Figure 1. Infrared spectra of amorphous Fe-Al-silicate smokes. The lower spectrum is the initial condensate. The middle spectrum is that of a sample which was immersed in liquid water for 5 days at 378 K and then freeze-dried. The top spectrum is that of a sample which has been vacuum annealed for 16 hrs. at 1200 K. Note that a scale change occurs at 2000 cm^{-1} .

